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A Markup Model for Forecasting Inflation for the Euro Area

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Abstract

In this note we use the methodology of Banerjee, Cockerell and Russell (2001) and Banerjee and Russell (2001) to develop a small model for forecasting inflation for the Euro-area using quarterly data over the period June 1973 to March 2002.

Keywords: Inflation, prices markup, business cycle, cointegration, forecasting

JEL Classification: C22, C32, C52, C53, D40, E31, E32

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1. INTRODUCTION

Recent work by Banerjee, Cockerell and Russell (2001) and Banerjee and Russell (2001) has demonstrated the existence of a long-run relationship between inflation and measures of the markup. These papers proceed from the maintained assumption that both these variables are integrated of order 1. In this note we use this methodology to develop a parsimonious model for forecasting inflation for the Euro-area, using quarterly data over the period June 1973 to March 2002.[1] Our model is in the spirit of Henry (1999) and Fagan, Henry and Mestre (2001). Alternative approaches are multi-country models of De Bondt, Els and Stokman (1997) and Deutsche Bundesbank (2000).

2. THE MODEL

The long-run structure of our model is given by:[2]

$$mu \;=\; q - \lambda\,\Delta p \qquad (1)$$

where mu is the markup of price on unit labour costs, q is the 'gross' markup, λ is the parameter that measures the trade-off in the long-run between inflation and the markup (referred to as the inflation cost coefficient), and p is the price level. Lower case variables are in natural logarithms and Δ is the first change in the price level. The markup is calculated as $p - ulc$ where the price level, p, is the gross domestic product (GDP) implicit price deflator measured at factor costs and ulc is a measure of unit labour costs.

1 The data are from Fagan, Henry and Mestre (2001) updated to March 2002. See the data appendix for further details.

2 We started by specifying the long run as $mu + rer = q - \lambda\Delta p$ where rer is a measure of the real exchange rate. However, the real exchange rate was found to be insignificant in the cointegrating vector and the model performed poorly in the late 1990s. On closer examination, the poor performance could be attributed to a change in the short-run dynamics of rer in the 1990s possibly due to the steps towards the introduction of a single currency. Ideally we would wish to estimate our model from early in the 1990s but the shortage of quarterly data precludes this.

This long run is nested within a two dimensional VAR-ECM as given below.

$$\begin{pmatrix} \Delta mu \\ \Delta^2 p \end{pmatrix}_t = \mu + \Pi x_{t-1} + \sum_{i=1}^{4} \Pi_i \Delta x_{t-i} + \Phi bc_{t-1} \quad \varepsilon_t \qquad (2)$$

where Π is the long-run matrix containing the cointegrating vectors, Δ^2 is the second change in the price level, and Π_i are the short-run matrices. The vector of unrestricted constants is given by μ and bc_{t-1} is a variable representing the business cycle.[3]

The GDP data for the Euro area are aggregated by the following operation on the real and nominal components of GDP for each country, $x_{EA} = \sum_{EA} w_i x_i$, where x_{EA} is the Euro area value of the component, x_i is the component series for country i and w_i is the weight for each country in terms of the share of constant price GDP at PPP of the country in Euro area GDP in 1995. The weights are provided on page 53 of Fagan *et. al.* (2001). The implicit price deflators are then calculated from the nominal and real aggregated components of Euro area GDP.

This method of aggregation avoids the difficulties associated with disentangling for the Euro area the intra area trade from trade outside the area for each of the countries. The drawback to this method is that intra Euro area exports and imports are not allocated to consumption, investment and government expenditures as they should be. Consequently, if the deflators for intra Euro trade diverge from the deflators for trade outside the Euro area then the deflators for each component will not approximate their ‘true’ component deflators for the Euro area. Given that the composition of intra Euro area trade differs from trade outside the Euro area, it is unlikely these deflators will move together. We estimate the model using the GDP deflator to avoid this problem.

[3] Construction of the business cycle variable is explained in the data appendix.

3. THE ESTIMATES

The coefficient estimates using data up to March 2002 are given in Table 1. The results show that we can accept the hypothesis of one negative long-run relationship between inflation and the markup. The estimate of the inflation cost coefficient is 4.925, implying that an increase of 1 percentage point in annual inflation is associated with a 1 ¼ percent fall in the markup in the long run. Also worthy of note are the coefficients on the business cycle variable showing that the change in the markup is counter-cyclical and the change in inflation is pro-cyclical.

The estimates reported are from the parsimonious model. The parsimony is surprising given how well it performs as an in-sample forecasting tool as shown in Graph 1. This in part reflects the stability of the estimated coefficients over the sample period. The in-sample estimates of inflation use the estimated coefficients from Table 1 and the actual (and not forecast) values for the business cycle. The values for the markup and inflation are those forecast by the model in sample, starting with the actual values in June 1973. A small-scale sensitivity analysis (not reported here) was undertaken to check the necessity of including variables such as real and nominal short interest rates, world demand, oil and energy prices and these turned out not to be important.[4]

Graph 2 and Table 2 provides out of sample forecasts for inflation over 8 quarters under two scenarios for the business cycle. The first assumes that GDP returns to, and remains at, its potential level from June 2002 until the end of the forecast period. Our model predicts that inflation would stabilise at around the level presently being experienced.

The second scenario shown in Graph 2 assumes that the time profile of the output gap is the same as in the recession between June 1993 and December 1994. The model predicts that a severe recession such as that experienced in the early 1990s will lead to negative inflation before the end of the forecasting period. The forecast of negative inflation is in contrast with the experience of the 1990s recession where inflation remained at a positive rate throughout. However, in the early 1990s recession, inflation started at around 3 ½ percent at an annual

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[4] Details are available on request from the authors.

rate instead of the currently prevailing inflation rate of around 1 ¾ percent. Forecasts can be easily constructed under alternative scenarios.

The graphs and the results demonstrate the value of our approach. The model captures the in-sample swings in the data successfully with an extremely parsimonious choice of variables. Another advantage is that inflation can be forecast conditional upon the forecast of only one variable, namely the output gap. What is lacking, however, is a formal comparison with a wider range of alternative forecasting approaches. Future work by us will report on this issue.

4. DATA APPENDIX

Euro area data seasonally adjusted for the period June 1972 to March 2002. Natural logarithms are taken of all variables before estimation proceeds. The data for the period June 1972 to March 2001 are updated data from Fagan *et al.* (2001) where further details may be found. The data was extended to March 2002 using Euro area data from the European Forecasting Network (EFN) data base which, in turn, makes use of data compiled by Eurostat.

Sources and Details of the Data[(a)]

Variable	*Mnemonics*	*Details*
Price Level	YFD	Gross domestic product (GDP) implicit price deflator at factor cost. The data is extended for the period March 2001 to March 2002 by forward splicing with the 'Deflator GDP' from the EFN data base.
Unit Labour Costs	ULC	Unit labour costs measured as compensation to employees (WIN) divided by constant price gross domestic product (YER). The data is extended for the period March 2001 to March 2002 using the EFN data base where unit labour costs are calculated as 'total nominal hourly labour costs for the whole economy' multiplied by 'employment' and divided by GDP measured at constant 1995 prices.
Business Cycle	YGA	Potential output gap defined as constant price GDP (YER) divided by potential output (YET). Potential output is estimated in Fagan *et al.* (2001) as a function of the level of employment consistent with the NAIRU (LNT), the capital stock (KSR), and trend total factor productivity (TFT). The business cycle is the residuals of the logarithm of the potential output gap (YGA) regressed on a constant and trend. Prior to de-trending, YGA was extended for the period March 2001 to March 2002 by: $YGA_t = YGA_{t-1} + \Delta LYER_t - average \Delta LYER$ where $\Delta LYER$ is the change in the logarithm of constant price GDP and the average is taken for the period of June 1972 to March 2001.

Mnemonics are from Fagan *et. al.* (2001).

5. REFERENCES

Banerjee, A., Cockerell, L. and B. Russell (2001). An I(2) An analysis of Inflation and the Markup, *Journal of Applied Econometrics*, Sargan Special Issue, vol. 16, pp. 221-240.

Banerjee, A. and B. Russell (2001). The Relationship between the Markup and Inflation in the G7 Economies and Australia, *Review of Economics and Statistics*, vol. 83, No. 2, May, pp. 377-87.

De Bondt G.J., P.J.A. van Els and A.C.J. Stokman (1997). EUROMON: A Macroeconometric Multi-Country Model for the EU, De Nederlandsche Bank Staff Reports no. 17.

Deutsche Bundesbank (2000). Macroeconometric Model: MEMMOD. Deutsche Bundesbank, Frankfurt.

Fagan, G., Henry, J. and R. Mestre (2001). An Area-Wide Model (AWM) for the Euro Area, European Central Bank Working Paper Series, no. 42, January.

Henry, J. (1999). Euro Area-Wide and Country Modelling at the Start of the EMU, *Economic and Financial Modelling*, Autumn, pp. 103-48.

Johansen, S, (1995). *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models*, Oxford University Press, Oxford.

Table 1: I(1) System Estimates

Long-run Estimates

	$mu = p - ulc$	Δp
Normalised Cointegrating Vector	1 [0.054]	4.925 [0.265]

Short-run Estimates

Variable	**Lag**	**Markup Equation** Δmu	**Inflation Equation** $\Delta^2 p$
Error Correction Term	-1	- 0.177 (- 6.0)	- 0.046 (- 2.4)
Constant		0.109 (6.0)	0.028 (2.3)
Change in Markup	-1	- 0.047 (- 0.6)	0.018 (0.4)
	-2	0.071 (0.9)	- 0.024 (-0.5)
	-3	- 0.090 (- 1.2)	0.026 (0.5)
	-4	0.186 (2.5)	0.000 (0.0)
Change in Inflation	-1	0.914 (5.0)	- 0.349 (- 2.9)
	-2	0.678 (3.7)	- 0.125 (- 1.0)
	-3	0.652 (3.7)	- 0.166 (-1.5
	-4	0.469 (3.2)	- 0.129 (- 1.4)
Business Cycle	-1	- 0.158 (- 3.8)	0.143 (5.3)
R^2		0.426	0.331

Standard errors reported as [ ], *t*-statistics reported as ( ). The implied long-run relationship, or dynamic error correction term, is: $ECM_t \equiv mu_t + 4.965\Delta p_t$.

Likelihood ratio tests: (a) test of the coefficient on inflation is zero is rejected, $\chi_1^2 = 32.05$, p-value = 0.00, (b) test of the coefficient on the markup is zero is rejected, $\chi_1^2 = 29.79$, p-value = 0.00; and (c) exclusion of a trend in the cointegrating space is accepted, $\chi_1^2 = 0.42$, p-value = 0.51.

Testing for the number of Cointegrating Vectors

Estimated trace statistics for the null hypothesis $H_0 : r=0$ is 32.47 {13.31}, and $H_0 : r=1$ is 0.19 {2.71}. Numbers in { } are the relevant 90 per cent critical values from Table 15.3 of Johansen (1995). Statistics computed with 5 lags of the core variables. The effective sample is June 1973 to March 2002 and has 116 observations with 104 degrees of freedom.

Table 1b: I(1) System Diagnostics

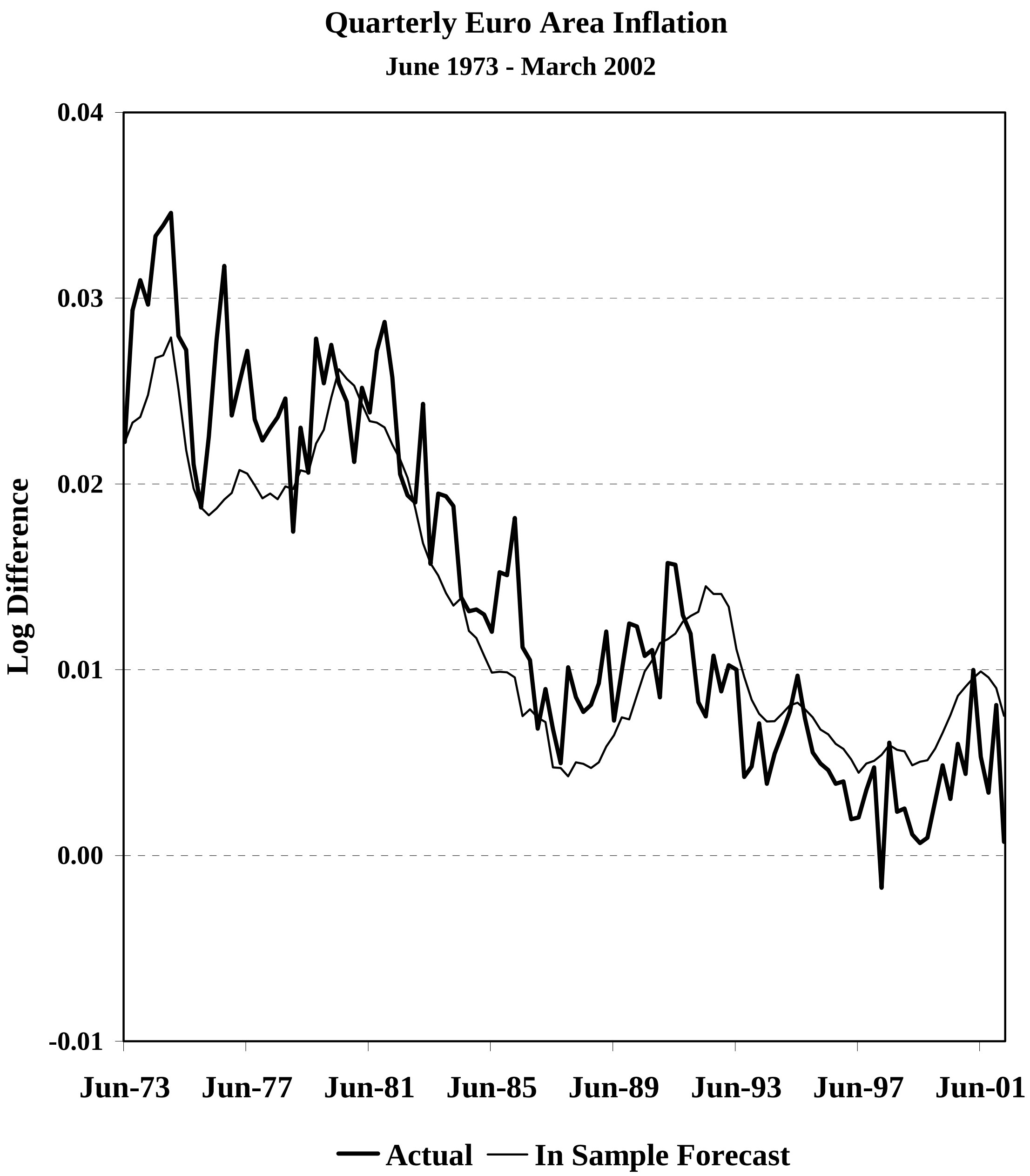
(a) Tests for Serial Correlation	
Ljung-Box (29)	$\chi^2_{98} = 80.92$, p-value 0.89
LM(1)	$\chi^2_{4} = 3.175$, p-value 0.53
LM(4)	$\chi^2_{4} = 2.287$, p-value 0.68
(b) Test for Normality: Doornik-Hansen Test:	$\chi^2_{4} = 1.594$, p-value 0.81

Table 2: Eight Quarter Inflation Forecasts

Period		Business Cycle	Forecast Inflation Scenario 1	Business Cycle	Forecast Inflation Scenario 2
2002	March (actual)	- 0.0123	0.0007	- 0.0123	0.0007
	June	0	0.0044	- 0.0144	0.0026
	September	0	0.0038	- 0.0177	0.0009
	December	0	0.0048	- 0.0173	0.0005
2003	March	0	0.0049	- 0.0163	- 0.0003
	June	0	0.0042	- 0.0137	- 0.0017
	September	0	0.0043	- 0.0083	- 0.0020
	December	0	0.0042	- 0.0024	- 0.0021
2004	March	0	0.0041	0.0015	- 0.0016

Note: The business cycle is log deviations from the mean potential output gap. Inflation is reported as the quarterly change in the logarithm of the price level

Graph 1


Quarterly Euro Area Inflation
June 1973 - March 2002
0.04
0.03
0.02
0.01
0.00
-0.01
Log Difference
Jun-73
Jun-77
Jun-81
Jun-85
Jun-89
Jun-93
Jun-97
Jun-01
Actual
In Sample Forecast

Graph 2

Forecasts of Quarterly Euro Area Inflation
June 2002 to March 2004